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General Certificate of Education
2019

Centre Number

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Candidate Number

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Chemistry

Assessment Unit AS 1

assessing

Basic Concepts in Physical
and Inorganic Chemistry

MV18

[SCH12]

MONDAY 20 MAY, MORNING

Time

1 hour 30 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all sixteen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all six** questions in **Section B**. **You must answer the questions in the spaces provided.**

Do not write on blank pages.

Complete in black ink only.

Information for Candidates

The total mark for this paper is 90.

Quality of written communication will be assessed in Question **15(c)**.

In Section A all questions carry equal marks, i.e. **one** mark for each question.

In Section B the figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

A Periodic Table of Elements, containing some data, is included with this question paper.

Section A – Multiple Choice

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

Each multiple choice question is worth 1 mark.

1 In which of the following does chromium **not** have an oxidation state of +6?

- A CrO_3
- B CrO_4^{2-}
- C $\text{Cr}_2\text{O}_7^{2-}$
- D Cr_2O_3

2 Which bonding type is described as intermolecular?

- A Covalent
- B Ionic
- C Metallic
- D van der Waals' forces

3 Which of the following is the formula of the nitrite ion?



4 25.0 cm^3 of 0.10 M sodium hydroxide solution is exactly neutralised by

A 12.5 cm^3 of 0.05 M sulfuric acid.

B 25.0 cm^3 of 0.05 M sulfuric acid.

C 12.5 cm^3 of 0.20 M sulfuric acid.

D 25.0 cm^3 of 0.10 M sulfuric acid.

5 The electronic configuration of a Group III element is

A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$.

B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$.

C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^2$.

D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^3$.

6 The bond angle in ammonia is

A 104.5° .

B 107° .

C 109.5° .

D 120° .

7 The sulfate(VI) ion can be reduced to sulfur dioxide.



Which of the following represents the correct values of x, y and z?

	x	y	z
A	2	2	4
B	2	4	2
C	4	2	2
D	4	4	2

8 Which type of titration can use phenolphthalein as a suitable indicator?

- A Strong acid/strong base only
- B Strong acid/strong base and weak acid/strong base
- C Strong acid/strong base and strong acid/weak base
- D Strong acid/weak base and weak acid/strong base

9 In which of the following molecules does the central atom obey the octet rule?

- A BF_3
- B BeCl_2
- C ClF_3
- D PH_3

10 Which species is the most powerful oxidising agent?

- A Bromide
- B Bromine
- C Chloride
- D Chlorine

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(Questions continue overleaf)

Section B

Answer all six questions in the spaces provided.

11 Water can act as an acid or as a base. It can either lose or gain hydrogen ions.

(a) State and explain the shape of a water molecule.
[3 marks]

(b) Water can react with hydrogen ions forming hydroxonium ions, H_3O^+ .

(i) Draw a dot and cross diagram to show the bonding in a hydroxonium ion, showing all the outer shell electrons. [2 marks]

(ii) Suggest why the bond angle in the hydroxonium ion is greater than the bond angle in water. [2 marks]

(iii) Suggest why the hydroxonium ion does not react with a hydrogen ion to form H_4O^{2+} . [1 mark]

12 Four new elements have recently been added to the Periodic Table. The four elements are given below, along with their atomic numbers and the mass numbers of their most common isotope.

element	atomic number	mass number
nihonium	113	286
moscovium	115	289
tennessine	117	294
oganesson	118	294

(a) What is the meaning of the following terms?

(i) Atomic number [1 mark]

(ii) Mass number [1 mark]

(iii) Isotopes [1 mark]

(b) State and explain which element has the most neutrons. [2 marks]

(c) Suggest why tennessine is placed in Group VII of the Periodic Table. [1 mark]

(d) Erbium is a soft, silvery solid that tarnishes slowly in air. It is used in fibre optic cables. There are six known isotopes of erbium and its relative atomic mass is 167.26.

(i) Define the term **relative isotopic mass**. [2 marks]

(ii) The table below gives the percentage abundances of six isotopes in the mass spectrum of erbium.

relative isotopic mass	161.93	163.93	165.93		167.93	169.94
% abundance	0.14	1.60	33.50	22.87	26.98	14.91

Calculate the missing relative isotopic mass.
[3 marks]

13 Chloroauric acid, HAuCl_4 , is an orange solid that is used widely in gold refining. During World War II, the Hungarian chemist George de Hevesy dissolved two gold Nobel Prize medals in a mixture of concentrated nitric and hydrochloric acids to prevent the Germans from confiscating them. Later the medals were reconstructed from the dissolved chloroauric acid and returned.

(a) The reaction between gold, concentrated hydrochloric acid and concentrated nitric acid produces chloroauric acid, nitrogen(IV) oxide and water. Write the equation for this reaction. [2 marks]

(b) Gold is extracted from recycled electronic materials by reaction with chlorine and hydrochloric acid, forming chloroauric acid. Elemental gold is recovered by electrolysis of chloroauric acid.



(i) Deduce the oxidation state of gold in chloroauric acid. [1 mark]

(ii) With reference to oxidation numbers, explain why this is a redox reaction. [3 marks]

(c) When heated, chloroauric acid forms gold(III) chloride and hydrogen chloride gas. The bonding in gold(III) chloride is considered to be covalent.

(i) Suggest, in terms of electronegativity, why the bonding in gold(III) chloride is covalent. [1 mark]

(ii) Describe the chemical test for hydrogen chloride gas. [2 marks]

14 The recommended daily allowance for salt, sodium chloride, is 6.0 g. Eating too much salt can lead to high blood pressure, potentially causing heart disease and strokes.

(a) State the electronic configuration of a sodium atom and use it to explain why sodium is regarded as an s-block element. [2 marks]

(b) (i) Define the term **Avogadro's constant**. [1 mark]

(ii) Calculate the number of sodium ions in the recommended daily allowance of sodium chloride. [2 marks]

(c) A solid sample of salt was analysed to confirm the identity of the ions present.

A flame test was first conducted on the sample using nichrome wire and concentrated hydrochloric acid to identify sodium ions. The presence of chloride ions was subsequently confirmed.

(i) State **two** reasons why **nichrome** wire was used. [2 marks]

(ii) State **two** reasons why concentrated hydrochloric acid was used. [2 marks]

(iii) State the colour observed in the flame test.
[1 mark]

(d) Describe how the presence of chloride ions could be confirmed in the solid salt. [4 marks]

(e) A second salt sample was thought to be contaminated with sodium carbonate. Describe a chemical test to confirm the presence of carbonate ions. [3 marks]

(f) The salt sample, of mass 6.0g, contaminated with sodium carbonate was dissolved in water. A solution of magnesium chloride was added, forming a precipitate of magnesium carbonate. The precipitate was filtered off and dried to give 1.4g of magnesium carbonate.

(i) Draw a dot and cross diagram to show the bonding in magnesium chloride showing all the outer electrons. [2 marks]

(ii) Write the equation for the reaction between sodium carbonate and magnesium chloride. [2 marks]

(iii) Use the following headings to calculate the percentage of sodium carbonate in the salt sample.
[6 marks]

Relative formula mass of magnesium carbonate

Number of moles of magnesium carbonate

Number of moles of sodium carbonate

Relative formula mass of sodium carbonate

Mass of sodium carbonate in the sample

Percentage of sodium carbonate in the sample

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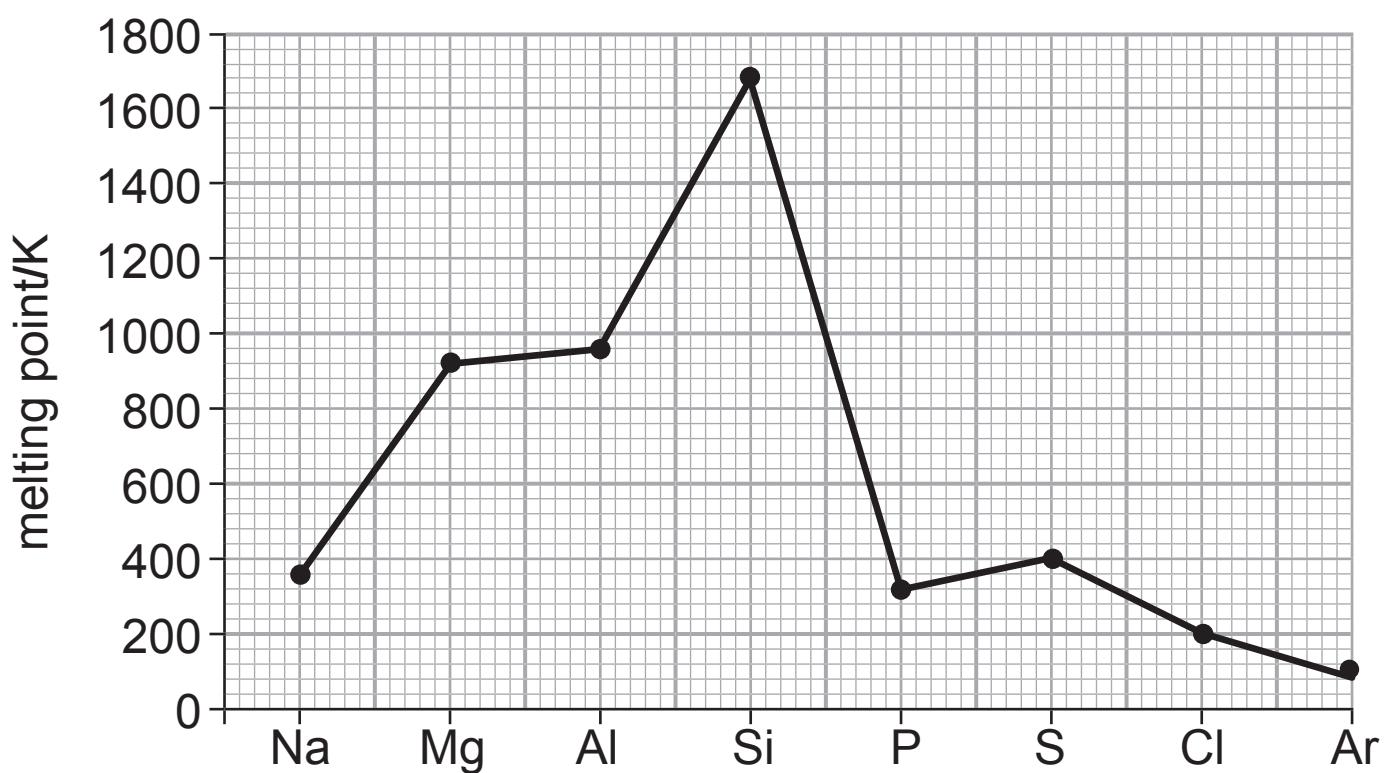
15 The third Period in the Periodic Table from sodium to argon displays a number of periodic trends.

(a) State and explain the general trend in first ionisation energy across Period three. [3 marks]

(b) (i) Write an equation, including state symbols, for the first ionisation energy of phosphorus. [2 marks]

(ii) Explain why the first ionisation energy of phosphorus is higher than that of sulfur. [2 marks]

(c) The graph below shows the melting points of the elements in the third Period.



With reference to the structure and bonding of the elements, explain the change in melting point from **silicon** to **argon**. [6 marks]

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

16 Lead(II) iodide is yellow and was once used as a pigment in paint until concerns over its toxicity led to its use being discontinued. It has a low solubility in water.

(a) Lead(II) iodide can be prepared by reaction between solutions of potassium iodide and lead(II) nitrate. Write the equation for this reaction. [2 marks]

(b) 75.6 mg of lead(II) iodide dissolve in 100 cm³ of water at 20°C. Calculate the molarity of iodide ions in a saturated solution of lead(II) iodide at 20°C. [4 marks]

(c) Chlorine water was added to potassium iodide solution in a test tube.

(i) State the colour observed. [1 mark]

(ii) A solution of starch was then added to the test tube. State the colour observed. [1 mark]

(d) (i) State **three** observations made when concentrated sulfuric acid is added to solid potassium iodide.
[3 marks]

(ii) Explain why concentrated phosphoric acid does not give iodine when added to solid potassium iodide.
[1 mark]

THIS IS THE END OF THE QUESTION PAPER

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General Information

1 tonne = 10^6 g

1 metre = 10^9 nm

One mole of any gas at 293 K and a pressure of 1 atmosphere (10^5 Pa) occupies a volume of 24 dm³

Avogadro Constant = 6.02×10^{23} mol⁻¹

Planck Constant = 6.63×10^{-34} Js

Specific Heat Capacity of water = 4.2 J g⁻¹ K⁻¹

Speed of Light = 3×10^8 ms⁻¹

Characteristic absorptions in IR spectroscopy

Wavenumber/cm ⁻¹	Bond	Compound
550–850	C–X (X = Cl, Br, I)	Haloalkanes
750–1100	C–C	Alkanes, alkyl groups
1000–1300	C–O	Alcohols, esters, carboxylic acids
1450–1650	C=C	Arenes
1600–1700	C=C	Alkenes
1650–1800	C=O	Carboxylic acids, esters, aldehydes, ketones, amides, acyl chlorides
2200–2300	C≡N	Nitriles
2500–3200	O–H	Carboxylic acids
2750–2850	C–H	Aldehydes
2850–3000	C–H	Alkanes, alkyl groups, alkenes, arenes
3200–3600	O–H	Alcohols
3300–3500	N–H	Amines, amides

Proton Chemical Shifts in Nuclear Magnetic Resonance Spectroscopy

(relative to TMS)

Chemical Shift	Structure	
0.5–2.0	–CH	Saturated alkanes
0.5–5.5	–OH	Alcohols
1.0–3.0	–NH	Amines
2.0–3.0	–CO–CH	Ketones
	–N–CH	Amines
	C ₆ H ₅ –CH	Arene (aliphatic on ring)
2.0–4.0	X–CH	X = Cl or Br (3.0–4.0) X = I (2.0–3.0)
4.5–6.0	–C=CH	Alkenes
5.5–8.5	RCONH	Amides
6.0–8.0	–C ₆ H ₅	Arenes (on ring)
9.0–10.0	–CHO	Aldehydes
10.0–12.0	–COOH	Carboxylic acids

These chemical shifts are concentration and temperature dependent and may be outside the ranges indicated above.

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New
Specification



Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
Advanced Subsidiary and
Advanced Level Examinations

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations

gce a/as examinations

chemistry

For first teaching from September 2016
For first award of AS Level in Summer 2017
For first award of A Level in Summer 2018
Subject Code: 1110

I
II

THE PERIODIC TABLE OF ELEMENTS

Group

III
IV
V
VI
VII
0

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen																	4 He Helium
7 Li Lithium	9 Be Beryllium																2 Ne Neon
23 Na Sodium	24 Mg Magnesium																10 Ar Argon
39 K Potassium	40 Ca Calcium	45 Sc Scandium	48 Ti Titanium	51 V Vanadium	52 Cr Chromium	55 Mn Manganese	56 Fe Iron	59 Co Cobalt	59 Ni Nickel	64 Cu Copper	65 Zn Zinc	70 Ga Gallium	73 Ge Germanium	75 As Arsenic	79 Se Selenium	80 Br Bromine	84 Kr Krypton
85 Rb Rubidium	88 Sr Strontium	89 Y Yttrium	91 Zr Zirconium	93 Nb Niobium	96 Mo Molybdenum	98 Tc Technetium	101 Ru Ruthenium	103 Rh Rhodium	106 Pd Palladium	108 Ag Silver	112 Cd Cadmium	115 In Indium	119 Sn Tin	122 Sb Antimony	128 Te Tellurium	127 I Iodine	131 Xe Xenon
133 Cs Caesium	137 Ba Barium	139 La* Lanthanum	178 Hf Hafnium	181 Ta Tantalum	184 W Tungsten	186 Re Rhenium	190 Os Osmium	192 Ir Iridium	195 Pt Platinum	197 Au Gold	201 Hg Mercury	204 Tl Thallium	207 Pb Lead	209 Bi Bismuth	210 Po Polonium	210 At Astatine	222 Rn Radon
223 Fr Francium	226 Ra Radium	227 Ac[†] Actinium	261 Rf Rutherfordium	262 Db Dubnium	266 Sg Seaborgium	264 Bh Bohrium	277 Hs Hassium	268 Mt Meitnerium	271 Ds Darmstadtium	272 Rg Roentgenium	285 Cn Copernicium						

* 58 – 71 Lanthanum series

† 90 – 103 Actinium series

a = relative atomic mass (approx)
x = atomic symbol
b = atomic number

a
X
b

140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	145 Pm Promethium	150 Sm Samarium	152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium
58 Th Thorium	59 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Berkelium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium